ALLEN B. DUMONT

440/440R

Type 440 Oscilloscope

Temporary

MP MASTER

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– Allen B. Dumont

DuMont

TYPES 440 AND 440R

OSCILLOSCOPES

INSTRUCTION MANUAL

ALLEN B. DU MONT LABORATORIES
DIVISIONS OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
INDUSTRIAL ELECTRONICS DIVISION
750 BLOOMFIELD AVENUE, CLIFTON, NEW JERSEY

Manual #6704 0331

SECTION 1

TECHNICAL SUMMARY

1-1. INTRODUCTION

This manual of Operating and Maintenance instructions covers information on both the Type 440 (bench model) and Type 440R (rack mounted) Oscilloscopes. Electrically, the two types are identical; mechanically, they differ in exterior appearance. These differences are clearly indicated in the text. Otherwise, references throughout the manual to the Type 440 pertain also to the Type 440R.

1-2. PURPOSE

The Du Mont Type 440 Oscilloscope is a measuring instrument designed to be used for almost any general application. The wide bandwidth of this instrument assures that it can be used with many laboratory and field maintenance applications, while dc amplification provides that the lowest frequency portions of signals will be faithfully reproduced.

1-3. FEATURES

- K1931-P1 tight tolerance cathode-ray tube with 5000 volts over-all accelerating potential; screen aluminization optional
- Provisions for differential or single-ended vertical and horizontal input signals. The vertical input is differential for all settings of the attenuator
- Frequency response and gain of the Y Amplifier extends from dc to 3 db down at 5 Mc at a sensitivity of 50 millivolts/cm
- Frequency response and gain of the X Amplifier extends from dc to 3 db down at 500 Kc at a sensitivity of 10 millivolts/cm
- Calibration voltage is provided for each amplifier
- Calibrated linear sweep rates from 200 milliseconds/cm to 1 microsecond/cm in fifteen steps of 1, 2, 5, and 10 sequence

- Uncalibrated linear sweep, continuously variable in rate from 1 second/cm to 0.2 microsecond/cm. Longest sweep time is 10 seconds full scale

- Provision for connection of external capacitance provided at rear of instrument for extension of sweep time

- Driven, automatic, or single (armed) sweep operation with automatic forward trace brightening

- Examination on the screen of any portion of sweep or X signal expanded up to at least five times full scale without distortion

- Provision for Z-Axis (intensity) modulation

- Provisions for direct access to the deflection plates of the cathode-ray tube

- All power supplies and heater voltage for critical tubes are regulated

1-4. LIST OF RECOMMENDED ACCESSORIES

Type or Part Number	Description
	FILTERS AND SCALES
4800 4511	Color filter, green for P1, P2, and P31 screen
4800 4512	Color filter, blue for P11 or P7 screen
4800 4513	Color filter, amber for P7 screen
4501 0261	Anti-parallax scale
	ATTENUATOR PROBE
4290	10:1 Attenuator Probe terminated in BNC type connector; 10 megohms, 10 pf input
4285	50-ohm, 2-watt termination
	KITS
4001	Sweep Rearming Kit
4002	Accessory Kit; includes the Anti-parallax Scale, Test Probe, Hood, and Electrical Test Fixture, Type 4002-A (8700 1224)
4003	Maximum Sweep Expansion Calibration Kit
4004	Sync Ready Indicator Kit
	TABLES
2601-A	Movable table, non-adjustable shelf
2602	Movable table, adjustable shelf
4270	Scope Traveler, collapsible
	TERMINAL ADAPTER
2592-B	Shielded terminal adapter, unterminated; this is a binding post to BNC type adapter
0903 6940	Connector, BNC type to binding post adapter; UG1090/U
	VIEWING ACCESSORY
276-C	Viewing Hood

1-5. TECHNICAL SUMMARY

The electrical and physical characteristics of the Types 440 and 440R are listed in Table 1-1 which follows.

TABLE 1-1

TECHNICAL SUMMARY

DU MONT TYPES 440 AND 440R OSCILLOSCOPES

CATHODE-RAY TUBE DATA

CRT	
Type	K1931-P31, tight tolerance, high resolution CRT is normally supplied; P1 for visual use; P7 phosphor for long persistence low frequency or transient observation; P11 for photographic use; and P2 phosphor for combination visual and photographic use are also available; aluminization for maximum light output is optional
Over-all Accelerating Potential	5000 volts
Bezel	Light-proof bezel provides firm mount for an oscilloscope camera and permits ready interchange of filters and scales
CRT Scale	Engraved edge-lit scale having 10 cm by 10 cm graduations and appropriate color filter over face of tube. Scale illumination control varies illumination level from zero to intensity adequate for photographic recording
CRT Scan	Full screen; usable area is greater than 32.5 square centimeters
CRT DIRECT INPUT (Terminals are available at rear of the instrument)	
X Axis	Deflection Factor: from 10 volts/cm to 14 volts/cm

TABLE 1-1. TECHNICAL SUMMARY (Continued)

CRT DIRECT INPUT (continued)	
Y Axis	Deflection Factor: from 10 volts/cm to 14 volts/cm. To use the direct input of the Y system, the output of D3 and D4 and the amplifier must be connected to the rear terminal board
Z Axis	Positive pulse to cathode of CRT blanks trace. 15 volts needed into an impedance of approximately 1000 ohms coupled via 0.01 μf capacitor. Time constant is approximately 10 milliseconds
VERTICAL-DEFLECTION SYSTEM	
BANDWIDTH	
Direct Coupled	DC to 5 megacycles; down 3 db ±1 db at 5 megacycles; usable beyond 10 megacycles
Capacitively Coupled	From 5 cycles to 5 megacycles
Rise Time	0.07 microsecond with less than 5% overshoot or preswing
SENSITIVITY	
Input Attenuation	Provided by a frequency compensated attenuator with steps from 50 millivolts/cm to 50 volts/cm, accurate to within 2% when set on any one step. An OFF position is included for dc balancing. The attenuator is balanced on all ranges for differential signal input; resistor tolerance is 1%
Calibrated Operation	From 50 millivolts/cm to 50 volts/cm in ten steps of 5, 10, and 20 sequence when VERNIER control is preset to CAL

TABLE 1-1. TECHNICAL SUMMARY (Continued)

VERTICAL-DEFLECTION SYSTEM (Continued)	
Uncalibrated Operation	Continuously variable from 50 millivolts/cm to 125 volts/cm. VERNIER control permits 2.5 to 1 continuous sensitivity adjustments between the attenuator steps and extends the 50 volts/cm range to 125 volts/cm. The VERNIER knob is provided with a push-pull switch to facilitate calibration check; the pulled knob indicates uncalibrated vernier gain setting
INPUT DATA	
Input Connectors	BNC connectors are provided for selection of one of two individual channel single-ended inputs, or dual use for differential input; a selector switch is provided. Input isolation is better than 30 db at 60 cycles and is not controlled at higher frequencies
Input Impedance	
Single-ended	1 megohm, constant within ±3% at all attenuator settings; nominally 47 pf (μμf) constant within ±5% from range to range; 2-megohm input impedance is available by removal of two resistors
Differential Input	2 megohms shunted by less than 40 pf (μμf); 4 megohms shunted by less than 40 pf (μμf) is available by removal of two resistors. The attenuator functions in differential mode in <u>all</u> positions
Input Coupling	
Single-ended	Direct or through capacitor of 500-volt rating to amplifier
Differential	Direct or through capacitor of 500-volt rating to amplifier

TABLE 1-1. TECHNICAL SUMMARY (Continued)

VERTICAL-DEFLECTION SYSTEM (Concluded)	
COMMON MODE	
Rejection Ratio	Nominally 120:1, always better than 100:1 (40 db). Applies to 50 mv/cm attenuator range only. Attenuator accuracy is additive on all other ranges
Maximum Signal	Common mode signal must not exceed ±3 volts dc plus peak ac
HORIZONTAL-DEFLECTION SYSTEM	
BANDWIDTH	
Direct Coupled	DC to 500 kilocycles; down 3 db ±1 db at 500 kilocycles Down 6 db at approximately 750 kilocycles when amplifier is set for calibrated operation
Capacitively Coupled	From 2 cycles to 500 kilocycles
Rise Time	0.8 microseconds with less than 3% overshoot or preswing
SENSITIVITY	
Input Attenuation	Provided by a frequency compensated attenuator with steps from 10 millivolts/cm to 10 volts/cm, accurate to within 2% when set on any one step. An OFF position is included for dc balancing
Calibrated Operation	From 10 millivolts/cm to 10 volts/cm in four decade steps when VERNIER control is preset to CAL
Uncalibrated Operation	Continuously variable from 10 millivolts/cm to 100 volts/cm. VERNIER control permits 10 to 1 continuous sensitivity adjustments between the decade attenuator steps and extends the 10 volts/cm range to 100 volts/cm

TABLE 1-1. TECHNICAL SUMMARY (Continued)

HORIZONTAL-DEFLECTION SYSTEM (Continued)

SENSITIVITY (continued)	
Positioning Range	5 times full screen
INPUT DATA	
Input Connectors	Combination binding posts spaced on 3/4-inch centers to accommodate the Du Mont Type 2592-B shielded terminal adapter. Two binding post connectors are provided for balanced horizontal input and a ground binding post and connector strap are provided for single-ended amplifier operation
Input Impedance	
Single-ended	1 megohm, constant within ±3% at all attenuator settings; nominally 47 pf (μμf), constant within ±5% from range to range
Differential	2 megohms shunted by less than 40 pf (μμf)
Input Coupling	
Single-ended	Direct or through capacitor of 600-volt rating to amplifier
Differential Input	10 millivolts/cm range (DC coupling only); adjustable to 100 millivolts/cm sensitivity by using the X VERNIER control
COMMON MODE	
Rejection Ratio	Nominally 120:1, always better than 100:1 (40 db); 10 millivolts/cm attenuator setting only
Maximum Signal	Common mode signal must not exceed ±3 volts dc plus peak ac

TABLE 1-1. TECHNICAL SUMMARY (Continued)

HORIZONTAL-DEFLECTION SYSTEM (Concluded)	
PHASE SHIFT	A phase shift trimmer capacitor is provided to adjust minimum phase differential between the X and Y systems at any point from low frequencies to over 100 Kc. Terminals are provided to permit additional capacity to be added for nulling phase over the above range
SYNCHRONIZATION	
TRIG INPUT COUPLING	
AC	High-pass filter; 80 cycles to low-frequency cutoff
DC	Direct coupled to: (1) preserve very low frequencies, (2) maintain the initial reference position of the trace with respect to the CRT scale at a given trigger level setting; and (3) avoid trigger point variations due to random repetition rate trigger signals
ACF	AC Fast differentiated trigger input; high-pass filter is provided to reject hum and low-frequency amplitude modulation; low-frequency cutoff nominally 10 Kc
SLOPE LEVELING	
Polarity	Selection of positive or negative slopes on Internal, Line, or External triggering is available
Trigger Level	A range of ±12 volts for External Trigger Input or 1-1/2 times full scale on internal triggering. Preset position provides fixed optimized sensitivity. On External/10 Trigger Source, the leveling range is extended to ±120 volts

TABLE 1-1. TECHNICAL SUMMARY (Continued)

SYNCHRONIZATION (Continued)

TRIGGER SENSITIVITIES	
Internal	Signals will synchronize from 1/2 centimeter of vertical signal on driven and single sweep position. Less than 2 millimeters are required in the auto triggering position. A choice of trigger polarity (slope) is available
Line	Line frequency synchronization can be selected in either polarity (slope) and the triggering point may be shifted with the TRIG LEVEL control
External	0.25-volt peak-to-peak (250 millivolts peak-to-peak) from dc to approximately 300 Kc will synchronize the sweep The 10 to 1 external trigger attenuator will permit trigger signals greater than 200 volts peak-to-peak (±100 volts) to be useful. Trigger leveling, polarity selection, and ac or dc coupling are included. 0.5-volt peak-to-peak will trigger the sweep from dc to over 500 Kc in Driven and Single Sweep positions. Approximately 0.4-volt peak-to-peak is required in Auto Triggering operation
AUTOMATIC TRIGGERING	Auto triggering is available in conjunction with preset or vernier trigger leveling on internal, external, and line trigger sources. Auto triggering simplifies synchronization and provides a continuous base line at a frequency of approximately 50 cycles. Auto triggering modes permit synchronization of signal frequencies in the range beyond 1 Mc

TABLE 1-1. TECHNICAL SUMMARY (Continued)

SWEEP CIRCUIT	
TIME BASE	
Calibrated	From 200 milliseconds/cm to 1 microsecond/cm in 17 steps. Step sequence in 1, 2, 5, and 10. An "off" position is included
Uncalibrated	Continuously variable, uncalibrated between ranges and extends the 200 milliseconds/cm range to 1 second/cm (10 seconds full scale)
Accuracy	Normally within 2%; always within 5% (averaged over range of 8 cm)
Sweep Expansion	5 times expansion about center of screen. Extends fastest sweep rate to 0.02 microsecond/cm. Sweep expansion rate continuously variable from less than 8/10 to greater than 5.*
Expanded Sweep Positioning	Sufficient to position any full scale portion of the expanded trace (50 cm) on the screen
Extension of Lower Sweep Rates	External Sweep Capacitor Terminals are provided on the rear panel for slower sweeps. See Section 2, Operation, for further details
Single Sweep	The single sweep mode permits but one driven sweep of the time base to appear on the screen until the sweep is reset. A reset adapter kit, the Du Mont Type 4001 is available for use with external resetting contact closures (as may be found on mechanical devices, Du Mont oscilloscope camera shutters, etc.)

* The Du Mont Type 4003 Maximum Sweep Expansion Calibration Kit is available for calibrated X5 expansion point.

TABLE 1-1. TECHNICAL SUMMARY (Continued)

SWEEP CIRCUIT (Concluded)	
TIME BASE (continued)	
Electronic Shutter	Controlled exposure brightening for multiple trace X-Y displays through use of driven sweep. This feature may be switched out by setting the sweep to the "off" position
OTHER CHARACTERISTICS	
BEAM POSITION INDICATORS	Four indicator lamps are located on the front panel to alert the operator as to the direction of the beam when it is positioned off the screen. The right-hand indicating lamp also functions as a reset indicator when used in conjunction with the single sweep mode
UTILITY SIGNALS	
Gate Out	Negative gate coincident with sweep time is available on a front-panel binding post. Amplitude is more than 5 volts negative into an impedance of 10,000 ohms
10-Volt DC Out	A 10-volt, high impedance dc voltage is available at the rear panel to facilitate triggering from external contact closures; accuracy ±20%
REAR TERMINALS ON RACK-MOUNTED UNIT	Front panel input connections are duplicated at the rear of the rack-mounted unit. Front/rear switching is provided on the X and Y amplifier inputs to allow choice of either

TABLE 1-1. TECHNICAL SUMMARY (Continued)

OTHER CHARACTERISTICS (Continued)	
REAR TERMINALS ON RACK-MOUNTED UNIT (continued)	front or rear connections. Rear connector input capacities are higher than the front-panel input capacities for the external trigger input and the rear terminals of the X and Y signal inputs.*
AMBIENT TEMPERATURES	
Operating	From 0°C to +40°C. The 401BR incorporates a thermal cutout to protect the unit when rack cooling is insufficient. Adequate ventilation and clearance around unit must be provided in rack installation to assure intake air below the specified ambient temperature
Storage	From -20°C to +85°C
INTERNAL CALIBRATOR	Line frequency trapezoidal wave signal injected into the amplifier behind the attenuator to standardize gain. Accuracy nominally 1%, always within 2%. Calibrator may be normalized to an external standard for optimum precision.

* Rear Y Input connectors are BNC type, while other rear connections are made via pin type jack.

TABLE 1-1. TECHNICAL SUMMARY (Concluded)

POWER SUPPLY

POWER REQUIREMENTS

Line Voltage	From 103.5 to 127.5 volts or from 207 to 255 volts at 60-cycle line
Line Frequency	Operation from 48 through 1000 cycles line voltage excursion is reduced at extremes of frequency range and where power line distortion exceeds 5%
Power	250 watts average; 275-volt amperes at 115-volt, 60-cycle line
DC Power Supplies	All supplies including the critical tube heaters are electronically regulated

PHYSICAL CHARACTERISTICS

BENCH MODEL

Height	15-1/2 inches	(39.4 cm)
Width	8-3/4 inches	(22.3 cm)
Depth	23-1/4 inches	(59.2 cm)
Weight	45 pounds	(20.4 kg)
Shipping Weight	55 pounds	(25 kg)

RACK-MOUNTED MODEL

Height	7 inches	(17.8 cm)
Width	19 inches	(48.4 cm)
Depth	22-23/32 inches	(57.6 cm)
Weight	45 pounds	(20.4 kg)
Shipping Weight	55 pounds	(25 kg)

SECTION 2

OPERATING INSTRUCTIONS

2-1. GENERAL

The Du Mont Types 440 and 440R Oscilloscopes are shipped with all tubes in place and ready to operate. Since these instruments are portable, no special installation procedure is required. The rack-mounted model has a front panel 19 inches wide by 7 inches high for mounting the instrument in a standard relay rack or cabinet. Mounting holes are provided on each side of the 440 for the attachment of slides.

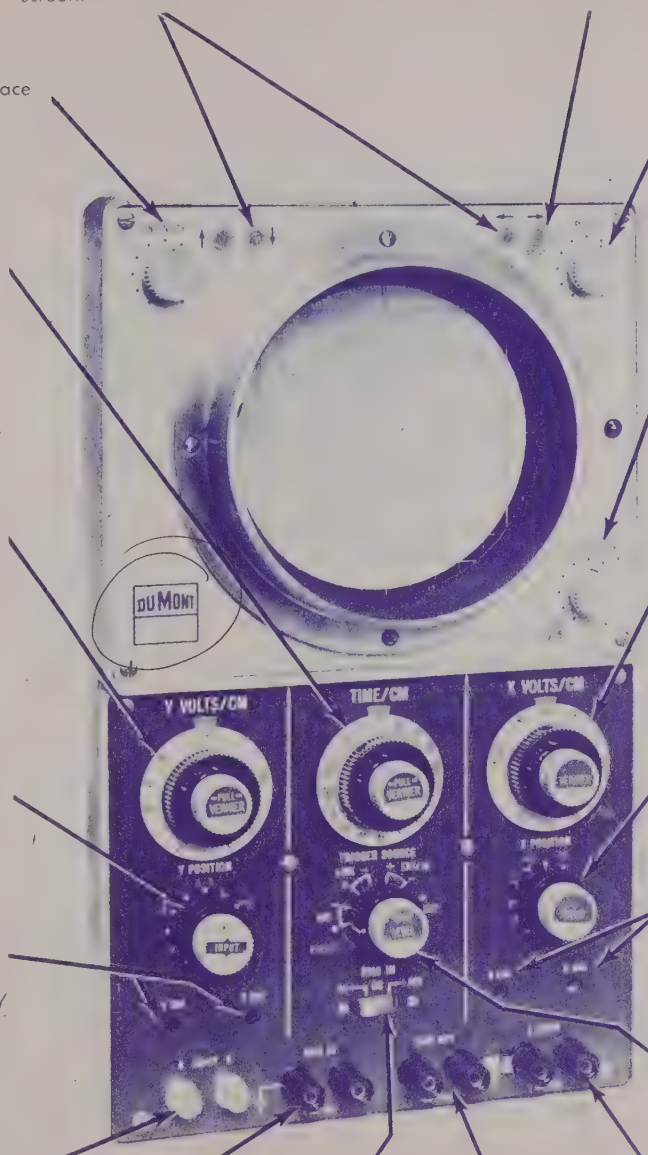
Normally these instruments may be placed where most convenient for viewing while at the same time maintaining short signal leads. Although shielding has been provided, operation in very strong magnetic fields may cause spurious deflections and should be avoided. Reorientation or additional shielding of the instrument may be necessary to minimize the effects of such fields.

The instrument is intended for operation from a 48 through 1000 cycles, single-phase, 115/230-volt power source. Refer to Table 1-1 for further details.

Numerous accessory components are available from the Allen B. Du Mont Laboratories to extend the usefulness of these oscilloscopes. See Section 1 for a complete listing.

2-2. THERMAL CUTOUT (Type 440R only)

A thermal cutout switch is connected in series with one side of the power line in the rack-mounted version of the Type 440. When the interior temperature of the instrument exceeds the safety limit, the thermal cutout switch will trip, removing power from the unit. It will reset itself when the interior temperature drops to a safe value. Possible causes of overheating are restriction of air circulation or high ambient temperature. Rack installation should be designed with a nominal clearance of 2 inches all around (1-1/2 inches minimum) and hot air must not be circulated through the oscilloscope.



BEAM POSITION INDICATORS: Indicates direction in which beam is off screen.

RESET: Right indicator light when lit indicates sweep requires resetting. Used with single sweep mode only

INTENSITY: Varies trace brightness

FOCUS: Adjusts trace sharpness

TIME/CM: Selects calibrated sweep rates as indicated on knob skirt

POWER & SCALE: Turns power on or off. Attached control varies scale illumination

VERNIER: Provides a 5:1 variation of sweep rate within limits of Time/Cm setting

X VOLTS/CM: Calibrated attenuator with steps from 0.01 to 10 volts/cm including positions DRIV, AUTO and SINGLE sweep

Y VOLTS/CM: Calibrated attenuator with steps from 50 millivolts/cm to 50 volts/cm

VERNIER: Provides a 10:1 variable adjustment permitting max gain and overlap of the X Volts/Cm setting

VERNIER: Provides a 2.5:1 continuous sensitivity adjustment between the attenuator steps and extends the 50 volts/cm range to 125 volts/cm

X POSITION: Positions trace horizontally

INPUT: Inserts blocking capacitor in X Input

Y INPUT AC/DC: Selects one of two individual channels for single-ended input, or selects channels A & B for differential input.

X CAL: Calibration adjustment of X Amplifier gain

X BAL: When adjusted, prevents horizontal movement of the trace when Vernier is varied

Y CAL: Calibration adjustment of Y Amplifier gain

Y BAL: When adjusted, prevents vertical movement of the trace when Vernier is varied

TRIG LEVEL: Determines voltage level horizontal trace will start

TRIGGER SOURCE: Eight position switch selects the source and slope for triggering

A/B INPUT: Connection for external signal to the Y Amplifier

TRIG IN: Connection for external sync signals through EXT positions of Trigger Source switch

TRIG IN: Selects one of three triggering modes, AC, DC, or ACF

GATE OUT: Provides a negative gate out for operation of auxiliary equipment

X INPUT: Connection for external signal to X Amplifier

FIGURE 2-1. FUNCTION OF CONTROLS AND CONNECTORS

2-3. PRECAUTION AGAINST SCREEN BURNING

A sharply focused spot of high intensity and small area should not be permitted to remain stationary on the screen for any length of time. Under such conditions, the entire beam energy is concentrated over a small area, thus subjecting the screen material to burning and discoloration. This condition is most likely to exist when using the unit for X-Y plotting with the INTENSITY control turned up, and no signal inputs. The INTENSITY LIMIT control R3119 located on the rear panel, may be adjusted to limit beam current to a safe value. A cathode-ray tube with aluminized screen is less susceptible to burning and is recommended for X-Y plotting for analog computers or other applications where single spot conditions may exist.

2-4. ILLUMINATED SCALE

The adjustable scale lighting control labeled SCALE ILLUM may be adjusted to suit the lighting conditions of the room or the f/number on the oscilloscope camera. The color filter supplied is tinted to provide the maximum trace contrast in the presence of room light. The colored filter should be mounted next to the cathode-ray tube so it does not block light from the calibrated scale, and should be removed when photographing the display. Do not mount the filter when maximum light output is desired.

The scale is accurately scribed in centimeters. These scale markings and the calibrated fixed attenuator markings and sweep rates, can be used to convert deflection in centimeters into volts and seconds. Vertical and horizontal sensitivities are accurately calibrated in volts per centimeter, and TIME/CM switch settings are accurately calibrated in seconds per centimeter, which when multiplied by the number of centimeters of deflection give the voltages and seconds.

2-5. BEAM POSITION INDICATORS

Four indicator lamps located above the bezel indicate the position of the beam on the CRT screen. The two beam indicators on the left of the bezel function with the vertical movement of the beam, and the two on the right function with the horizontal. When one of the indicator lamps lights, it indicates the direction in which the display is positioned off screen thus indicating the direction in which to turn the POSITION

control to return the display to the screen. The indicators also enable the display to be positioned on screen when the INTENSITY control level is set so low that the trace is invisible. The indicators are not calibrated, hence they do not show the exact location of the beam.

The right indicator lamp with RESET lettered beneath it is used during single sweep operation. When lit, it indicates the sweep requires rearming. Refer to Section 2-14c for further details.

2-6. FIRST-TIME OPERATION

a. INSTRUCTIONS

To place the instrument in operation, plug the power cord into the proper grounded power source and turn INTENSITY control counterclockwise. Rotate the SCALE ILLUM control clockwise to apply power. Allow approximately 10 minutes for the instrument to warm up. In the instructions which follow, the words in capital letters within the text indicate front-panel controls, connectors, or settings. A brief description of the front-panel controls and connectors is given in Figure 2-1.

b. INITIAL CONTROL SETTINGS

The operator is advised to follow the specific instructions and sequence of operation as outlined in this section. Set the various front-panel controls as indicated in Table 2-1. A pattern as indicated in Figure 2-2 should appear on the screen. At this time the operator may familiarize himself with the various controls and their effect on the built-in calibrator signal.

TABLE 2-1

INITIAL CONTROL SETTING	
Control	Setting
Y VOLTS/CM	CAL
TIME/CM	2 MS/CM
X VOLTS/CM	AUTOmatic Sweep
VERNIERS (all three)	CAL
X & Y POSITION	Centered
Y INPUT	AC, Connector A
X INPUT	AC
TRIGGER SOURCE	+INT
TRIG LEVEL	PRESET
TRIG IN	AC
INTENSITY	Suitable brightness
FOCUS	Sharp trace

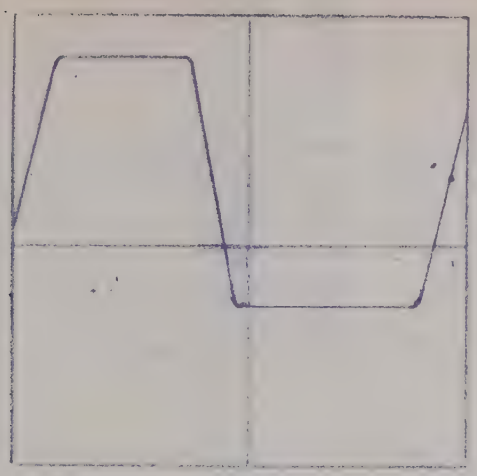


FIGURE 2-2. CALIBRATOR WAVEFORM DISPLAY

2-7. EFFECT OF THE AC/DC SWITCH

a. GENERAL

Three separate AC/DC switches are employed in this instrument. Each switch permits the choice of retaining the dc level of the input signal or blocking the dc component of the input signal by inserting a blocking capacitor, one each in series with the input of the vertical and horizontal deflection amplifiers, and one in the input of the Trig Amplifier and Level Selector.

When these switches are set in the AC position, the effect of the dc component is excluded from the display. When set in the DC position, the ac signal and dc level of the waveform can be noted. The dc component will cause the entire display to be depositioned on the screen.

Reset switches to the AC position.

b. Y AMPLIFIER INPUT SELECTOR SWITCH

The Y Amplifier input selector switch is labeled INPUT AC/DC. This is a 6-position switch and provides the following selections:

1) DC coupled signal through INPUT A connector, normal polarity;

2) DC coupled signal through INPUT B connector, inverted polarity;

3) DC coupled differential (balanced) input using INPUT A and INPUT B connectors;

4) AC coupled signal through INPUT A connector, normal polarity;

5) AC coupled signal through INPUT B connector, inverted polarity;

6) AC coupled differential (balanced) input using INPUT A and INPUT B connectors.

c. X INPUT AC/DC SWITCH

The X INPUT switch selects the desired AC/DC position for signals applied to the horizontal deflection amplifier.

d. TRIG IN SWITCH

The TRIG IN control is a 3-position slide switch and provides the following modes of trigger coupling:

1) AC: this mode may be used for general purpose trigger coupling. The low-frequency cutoff is approximately 80 cycles to avoid disturbing internal triggering while vertically positioning the pattern.

2) ACF: this mode is used primarily to reject low-frequency amplitude modulations in the trigger source. In the ACF position, a high-pass filter is inserted which rejects low-frequency components below 10 Kc. When used with signals having insignificant signal content below 10 Kc, such as the internal line frequency calibrator, unsatisfactory triggering will result.

3) DC: this mode is used to maintain the initial reference position of the trace on the CRT scale at a given trigger level setting; and to avoid the effects of random repetition rate trigger signal.

2-8. EFFECT OF THE FRONT-PANEL BAL CONTROLS

a. Y BAL

Set the Y VOLTS/CM switch to OFF; pull the Y VERNIER control and turn it counterclockwise. The reference trace on the screen should move vertically while rotating the VERNIER control throughout its range.

If trace shifts vertically, proceed as follows:

1) Turn VERNIER control counterclockwise.

2) Position trace to center of screen.

3) Turn VERNIER control clockwise.

4) Adjust the Y BAL control to bring trace back to center of screen.

5) Repeat this procedure until no depositioning of the trace is noted when the VERNIER control is rotated throughout its range.

Reset the Y VOLTS/CM switch to CAL and push in the VERNIER control knob.

b. X BAL

Set the X VOLTS/CM switch to OFF and turn the X VERNIER control counterclockwise. The reference trace on the screen should not move horizontally while rotating the VERNIER control throughout its range.

If trace shifts horizontally, repeat steps 1 through 5 in paragraph 2-8a above, using the X BAL and X VERNIER controls.

Reset the X VOLTS/CM switch and VERNIER control to CAL.

2-9. EFFECT OF THE Y VOLTS/CM SWITCH

With a signal of approximately 2.5 volts peak-to-peak applied to INPUT A, turn the Y VOLTS/CM switch to positions both to the right and left of the 0.5 setting. Notice that when the control is set to the higher number setting, the amplitude of the waveform is reduced and vice versa.

Reset the Y VOLTS/CM switch to 0.5 position. Pull the VERNIER control and turn it counterclockwise. Notice that counterclockwise movement of the VERNIER control decreases the amplitude of the signal being displayed and clockwise rotation increases the amplitude. When the VERNIER control is pushed in, the signal is restored to its original calibration. Thus, it is seen when a given voltage is applied to Y INPUT, the Y VOLTS/CM and VERNIER controls are used for adjusting the amplitude of the resulting vertical deflection. Note that the pushed-in VERNIER knob is now an indication of calibrated gain. Remove input signal and reset Y VOLTS/CM switch to CAL.

2-10. EFFECT OF THE TRIGGER SOURCE SWITCH

The TRIGGER SOURCE switch permits selection of the source and polarity of the sweep triggering signal.

a. POSITIVE POLARITY (+INT)

Set front-panel controls in accordance with Table 2-1, except place the X VOLTS/CM switch in DRIVen and adjust Y VERNIER control for 4 centimeters of vertical deflection. Observe the left side or beginning of the trace. Notice that it starts during the rising portion of the waveform indicating that the sweep is triggered at a time when the slope of the waveform is positive. See Figure 2-3.

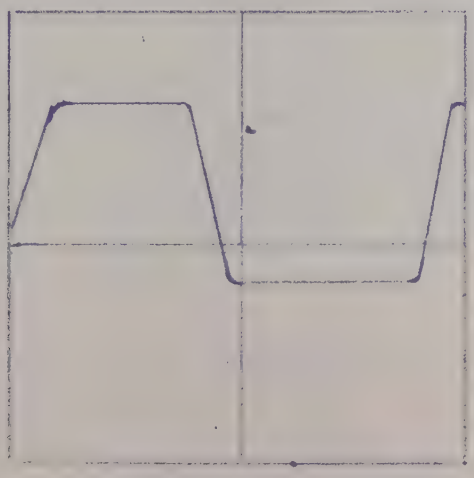


FIGURE 2-3. TRIGGER SOURCE SWITCH SET TO +INT

b. NEGATIVE POLARITY (-INT)

Reset TRIGGER SOURCE switch to -INT and notice that the waveform appears to have turned upside down. In the -INT position, the trace begins on the falling portion of the waveform indicating that the sweep is triggered at a time when the slope of the waveform is negative. See Figure 2-4.

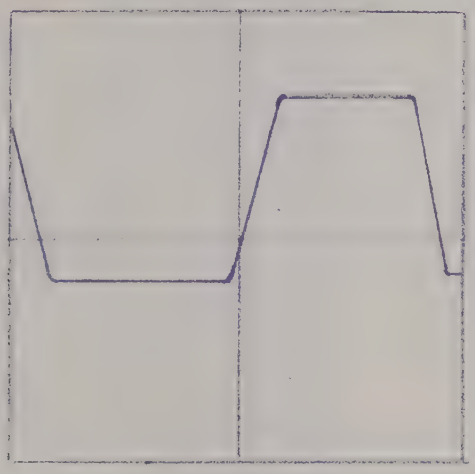


FIGURE 2-4. TRIGGER SOURCE SWITCH SET TO -INT

2-11. EFFECT OF THE TRIG LEVEL CONTROL

The TRIG LEVEL control permits selection of specific voltage the triggering signal must exceed before the sweep fires. A preset position on the TRIG LEVEL control permits ready availability of a stable, resettable, sensitive trigger level which will perform 90% of all triggering.

a. AC TRIGGERING MODE

The TRIG LEVEL control determines the point on the waveform where the display starts.

1) Set the TRIGGER SOURCE switch to +INT, and notice that the display starts on the rising portion of the waveform where the slope is positive.

2) Rotate the TRIG LEVEL control slowly in the clockwise direction and observe that as the control switches from the PRESET position, the trace disappears. As the control is rotated more in the clockwise direction, the display reappears and the start of the display shifts to fire on the higher portion of the waveform. See Figure 2-5.

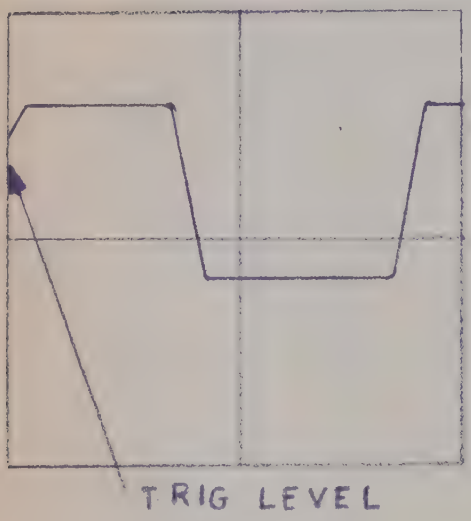


FIGURE 2-5. EFFECT OF TRIG LEVEL CONTROL WHEN SLOPE IS POSITIVE

3) Rotate the TRIG LEVEL control slowly in the counterclockwise direction and observe that the display starts on the lower part of the waveform. When in the PRESET position, the original calibrated waveform is restored. See Figure 2-6.

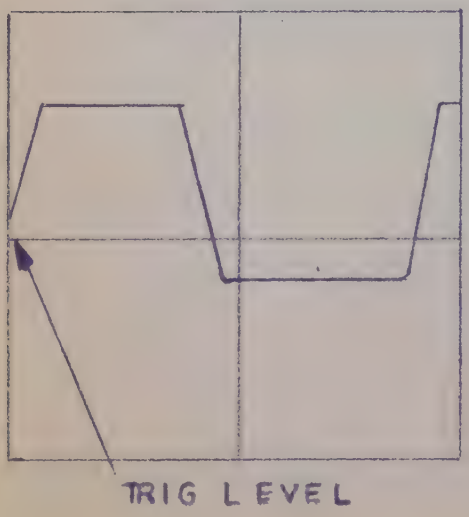


FIGURE 2-6. EFFECT OF TRIG LEVEL CONTROL WHEN SLOPE IS POSITIVE

4) Set the TRIGGER SOURCE switch to -INT, and notice that the waveform appears to have turned upside down. The display is now beginning during the falling part of the waveform where the slope is negative.

5) Rotate the TRIG LEVEL control slowly in the clockwise direction and observe that the display starts on the higher portion of the waveform. See Figure 2-7.

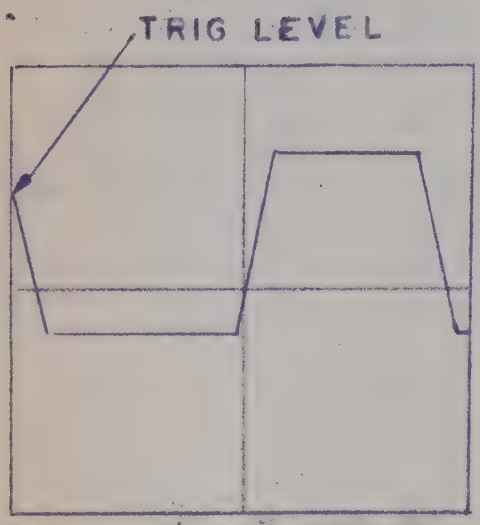


FIGURE 2-7. EFFECT OF TRIG LEVEL CONTROL WHEN SLOPE IS NEGATIVE

6) Rotate the TRIG LEVEL control slowly in the counter-clockwise direction and observe that the display starts on the lower portion of the waveform. See Figure 2-8.

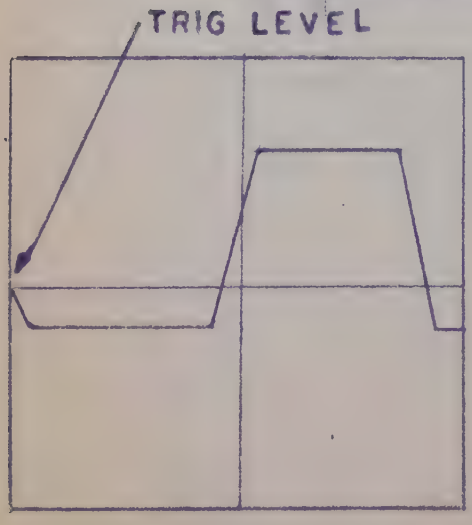


FIGURE 2-8. EFFECT OF TRIG LEVEL CONTROL WHEN SLOPE IS NEGATIVE

7) Reset TRIG LEVEL control to PRESET and TRIGGER SOURCE switch to +INT.

8) Set X VOLTS/CM switch to DRIVen Sweep and rotate Y VERNIER control to give a pattern of 3 centimeters of vertical deflection. Rotate the Y POSITION control back and forth observing the left side of the display as it is positioned up and down. Notice that for any setting of the TRIG LEVEL control, the trace always starts at the same point on the waveform regardless of the setting of the Y POSITION control. See Figures 2-9 and 2-10.

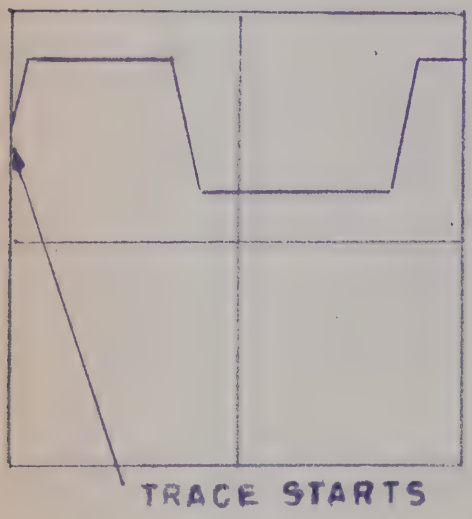


FIGURE 2-9. VERTICAL POSITIONING IN THE NORMAL AC MODE

Display positioned upward

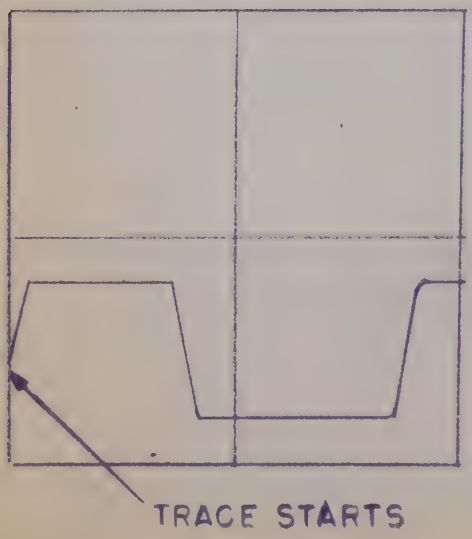


FIGURE 2-10. VERTICAL POSITIONING IN THE NORMAL AC MODE

Display positioned downward

b. DC TRIGGERING MODE

1) Set TRIG IN switch to DC. You are now triggering in the DC mode. Slowly turn the TRIG LEVEL control throughout its range observing the left side of trace. Note that the results are similar to those obtained when using AC mode. Set the TRIGGER SOURCE switch to -INT and again operate the TRIG LEVEL control. Note again that the results are similar to those obtained when using the AC mode.

2) Reset TRIGGER SOURCE switch to +INT, TRIG LEVEL control to PRESET, and Y VERNIER control to CAL.

3) Rotate Y POSITION control throughout its range observing the left side of the display as it is positioned up and down. Notice that for a given setting of the TRIG LEVEL control, the trace starts at the same point on the Scale regardless of the setting of the Y POSITION control. If you position the display above or below the setting, the trace will disappear. See Figures 2-11, 2-12, and 2-13.

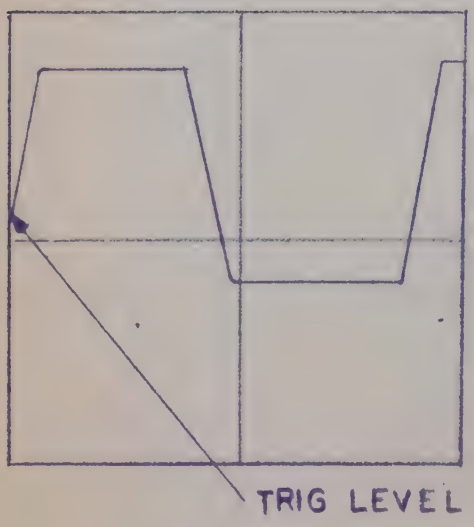


FIGURE 2-11. VERTICAL POSITIONING IN THE NORMAL DC MODE

Display positioned upward

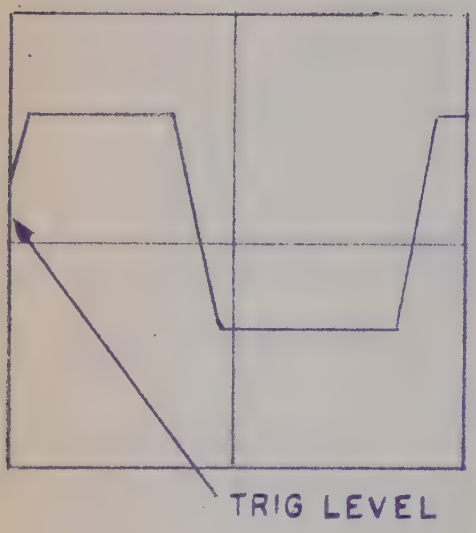


FIGURE 2-12. VERTICAL POSITIONING IN THE NORMAL DC MODE

Display centered

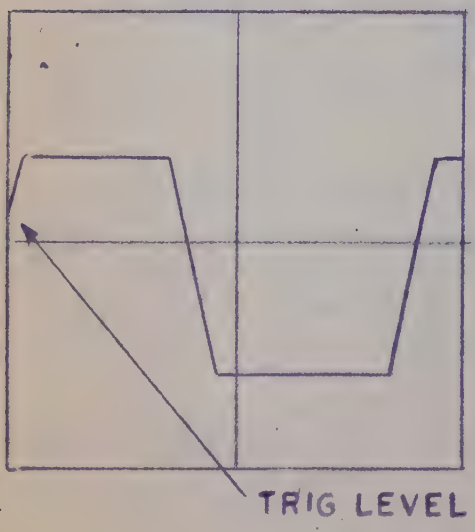


FIGURE 2-13. VERTICAL POSITIONING IN THE NORMAL DC MODE.

Display positioned downward

c. SUMMARY OF AC, ACF, AND DC TRIGGERING MODES

In summary, the following statements may be made to compare the AC, ACF, and DC modes of triggering.

1) When using the AC mode, the TRIG IN switch is set to AC, the trace always starts at the same point on the Waveform for a given TRIG LEVEL control setting regardless of the vertical positioning.

2) When using the DC mode, the TRIG IN switch is set to DC, the trace always starts at the same point on the Scale for a given setting of the TRIG LEVEL control regardless of the vertical positioning.

3) The DC mode is especially useful for viewing waveforms which change very slowly and which are therefore discriminated against by the low-frequency cutoff of the AC position (80 cps). Because of the coupling network time constant in the AC mode, signals having random repetition rates are sometimes viewed more stably in the DC mode.

4) The ACF mode is a special high-frequency form of the AC mode and is used to reject low-frequency components in the triggering signal. Use AC triggering unless low-frequency rejection is required. Triggering signals with frequency components below 10 Kc, for example the calibrator signal, will not initiate the sweep circuits when the ACF mode is used.

NOTE: The Du Mont Type 4004 Sync Ready Indicator Kit is available as an optional feature. The Sync Ready Indicator is lit whenever the trigger channel is ready to accept signals. The lamp may be set for "just on" with the TRIG LEVEL control to obtain maximum trigger sensitivity. Conversely, the TRIG LEVEL control may be appropriately backed off from the indicator "just on" position for reductions in trigger sensitivity. Setup of triggering for single sweep mode and use of dc triggering is therefore simplified.

A schematic of the Du Mont Type 4004 Kit is shown on Reference Drawing 9800 2103-4, Sheet 3 of 4.

2-12. OPERATING HINTS FOR THE VERTICAL DEFLECTION CHANNEL

a. APPLYING A SIGNAL TO THE OSCILLOSCOPE

Observe the following precautions when applying signals to the oscilloscope:

1) Avoid errors in readings due to stray coupling between circuits, particularly in the signal lead. As a rule, do not use long unshielded leads for applying signals to the oscilloscope. This fact holds for the audio-frequency spectrum, except possibly when making measurements on low-impedance circuits at very low

(continued on next page)

frequencies. When shielded leads are used, the shields should be grounded to the oscilloscope ground terminal and to the chassis of the equipment being tested. Coaxial or shielded input cables are recommended for most applications.

2) In broadband applications, it may be necessary to terminate a coaxial cable with a resistance equal to its characteristic impedance. This is done to prevent standing waves or ringing (high-frequency damped oscillations).

3) As the length of the cable is increased, the necessity for proper termination becomes very important. This termination is generally inserted at the oscilloscope end of the cable, although many signal sources may require an additional termination at the other end of the cable.

4) To avoid erroneous results, the operator should simulate the actual operating conditions of the equipment being tested. For example, the equipment should work into a load impedance equal to that which it will see in actual use.

5) Consider the effect of loading upon the signal source due to the input impedance of the oscilloscope. The input impedance can be represented by a resistance shunted by a capacitance. The effective value of this impedance is indicated in Table 1-1 of this manual. However, the operator should be aware that even with a few feet of cable in the input circuit, the loading capacitance on the circuit under investigation might be greater than 100 pf ($\mu\mu$f).

6) There are cases when connecting the input of the oscilloscope to a signal source, the effect of loading the source is not negligible. To minimize this loading, and therefore obtain a valid measurement, a probe may be used in the manner described in the paragraph entitled "Use of Probes".

7) The Du Mont Type 4290 Attenuator Probe is recommended for general purpose use. Refer to the Accessory section of your Du Mont catalog and Section 1 of this manual for a listing of cables, terminating resistors, and pads.

b. INPUT COUPLING

There are times when it is neither necessary nor desirable to display the dc component of the input waveform. A capacitor placed in series with the input connector will exclude the dc component while simultaneously permitting the ac component to be displayed. This is accomplished when the Y INPUT selector switch, the X INPUT switch, or the TRIG IN switch is set to AC.

Care must be exercised when applying a fast rise, high-frequency signal to the input connector. It will be necessary to match and properly terminate the coaxial cable applying the signal to the oscilloscope.

c. SINGLE-ENDED Y INPUT

Signals to be observed are connected to the vertical channel through connector INPUT A or INPUT B. The Y INPUT selector switch permits choice of input connector, polarity, and capacitive or direct coupling of the signal to the compensated attenuator. When two different signals are applied to the instrument, a quick comparison between them may be made by switching from INPUT A to INPUT B by use of the Y INPUT selector switch.

d. VERTICAL AMPLIFIER DIFFERENTIAL INPUT

For differential Y Input, set the Y INPUT AC/DC selector switch to AC, A-B position or DC, A-B position. Apply the desired signal to the INPUT A and INPUT B BNC connectors.

In the 50 mv/cm position, the common mode rejection is nominally 40 db. Use of 1% attenuator resistors slightly reduces this figure on all other ranges.

e. HORIZONTAL AMPLIFIER DIFFERENTIAL INPUT

For differential X Input, remove the link from the normally grounded X INPUT terminal. The X VOLTS/CM switch must be set to the 0.01 DC position. If there is an inphase signal (common mode) riding on the balanced-input signal, the permissible input voltage (dc plus peak ac) will be reduced accordingly.

f. DIFFERENTIAL INPUT FEATURES

One of the salient features of the three-terminal balanced-to-ground input circuit, is the behavior of the differential amplifier. This circuit makes it possible to reject to a considerable degree any common-mode signal, while at the same time passing and amplifying the differential input signal. Thus, if there is any balanced-to-ground pickup of noise on test leads or in the equipment under test, such noise will be reduced materially on passing through the differential amplifier circuit. The maximum amplitude of such signals should not be greater than ±3 volts with respect to ground for optimum performance.

2-13. USE OF PROBES

An attenuator probe lessens both the capacitive and resistive loading caused by the oscilloscope to a minimum value. Simultaneously, while isolating the oscilloscope from the signal source, it reduces the effective sensitivity of the instrument. In other words, the displayed waveform will be reduced in amplitude by the attenuation factor of the probe. The attenuation introduced by the probe permits measurement of signal voltages in excess of those which may be accommodated by the instrument.

When using a probe to sample signals from a tuned, matched, or otherwise critical circuit, capacitive loading may cause erroneous readings. In these cases it may be necessary to add capacity and resistance to the circuit under intended observation of a value precisely equal to that of the probe impedance after the probe is removed from the circuit. This substitution will equalize loading and restore the measured characteristics of the circuit under observation.

When using the attenuator probe to make amplitude measurements, multiply the observed amplitude of the display by the attenuation factor marked on the probe.

The Du Mont Type 4290 Accessory Probe has an attenuation factor of 10 to 1. The maximum voltage that may be applied to the probe is 1200 volts peak-to-peak, 600 volts dc. Voltages in excess of this value (either dc volts or peak ac volts) may cause damage to components inside of the probe housing.

IMPORTANT: Before using the probe, always check its adjustment.

An adjustable capacitor in the probe body compensates for variations in input capacitances from one unit to another. To insure accuracy in pulse and transient measurements, check the probe adjustment frequently. To check the probe, set the TRIG LEVEL control to PRESET, TIME/CM control to 500 μs/cm, and X VOLTS/CM switch to AUTO. Apply the probe tip to the GATE OUT connector. Adjust the probe capacitor for a flat trace on the screen,

To preserve the waveform of the signal being displayed, clip the probe ground lead to the chassis of the equipment being tested. Select a short clean ground point near the probe input connection.

The Du Mont Type 4290 Attenuator Probe may be connected directly to the Y Input BNC connectors. A BNC-to-binding post adapter, Du Mont Type 2592-B, is required when the Type 4290 Probe is connected to the X INPUT binding posts.

2-14. OPERATING HINTS FOR THE SWEEP CHANNEL

a. AUTOMATIC SWEEP

In some applications, it is desirable to have the sweep free-running, whether synchronized or not. When using the AUTO mode, a horizontal reference trace will appear on the screen even in the absence of an input signal. This AUTOmatic mode is very useful while testing equipment since a reference trace will always be visible regardless of whether a signal is applied to the oscilloscope or not.

The AUTO mode simplifies synchronization of signals or periodic waveforms having repetition rates greater than 50 cycles.

To obtain AUTOmatic sweep operation, set controls as outlined under paragraph entitled "Driven Sweep", except turn X VOLTS/CM switch to AUTO position.

NOTE: The TRIGGER LEVEL control permits level selection even though the sweep is in AUTO mode.

b. DRIVEN SWEEP

A stable pattern for practically all types of signals can be obtained by using driven sweep. Its use is mandatory for viewing random or non-periodic signals of low repetition rate. When operating the instrument in this manner, one sweep occurs for each single triggering impulse. Use of the driven sweep mode of operation in the majority of applications, is the preferred condition under which optimum performance can be expected of this instrument.

When the oscilloscope is set for DRIVen Sweep, the spot will be visible only during forward sweep time. The INTENSITY control must be properly adjusted to make the sweep visible. Intensity should not be set so bright as to override the retrace blanking. For DRIVen sweep operation, proceed as follows:

1) Apply desired signal to INPUT A and set front-panel controls as follows:

Control	Position
X VOLTS/CM	DRIVen Sweep
Y VOLTS/CM	Set for approximately 5 cm of deflection
Y INPUT Selector	A/AC
VERNIERS (all three)	CAL
TRIGGER SOURCE	+INT
TRIG IN	AC

2) Adjust TRIG LEVEL control to initiate the sweep and the POSITION controls to center the pattern.

3) Adjust Y VERNIER control in conjunction with Y VOLTS/CM switch to obtain a vertical deflection of approximately 5 centimeters.

4) Adjust X VERNIER control to expand the trace. If display tends to move off screen or otherwise does not expand about the center of the sweep, adjust the X BAL control to position it back on screen. (Refer to paragraph 2-8).

5) Rotate the TIME/CM control and adjust the VERNIER controls to obtain the desired number of cycles. Readjust the TRIG LEVEL control if necessary.

6) Adjust INTENSITY and FOCUS controls to obtain a sharp trace of suitable brightness.

7) If there is any multiple triggering of the sweep, the TRIG LEVEL control may be adjusted to select the signal levels which will best actuate the trigger circuit. Thus, undesirable signals of lesser amplitude will not affect the sweep.

8) Set TRIG IN switch to ACF to obtain a more stable display when using high-frequency triggering signals.

c. SINGLE-SWEEP OPERATION

Single-sweep operation infers that the time base moves but one stroke until reset. Reset may be accomplished by setting the X VOLTS/CM switch to RESET, or through external contact closures.

Using a repetitive sweep to view a varying waveform would result in an overlapped and unintelligible display caused by many cycles of the single trace being superimposed on one another. However, when it is desired to view a single display of an input signal which continually varies in amplitude, shape, or time, the X VOLTS/CM switch should be set to SINGLE, for single-sweep presentation. Thus, by commanding but one stroke of the sweep at a time, the SINGLE position eliminates the overlapping caused by the multiple traces and enables the display to be viewed and/or recorded clearly.

1. INTERNAL RESET

A single trace will sweep across the screen each time the sweep is triggered. At the end of its travel, the beam will rest off screen, and the right beam position indicator, with RESET lettered beneath it, will light indicating that the sweep requires rearming (resetting). To rearm the sweep, turn X VOLTS/CM switch from SINGLE to RESET and back to SINGLE position. The indicator light will go out indicating the sweep is armed and ready to fire on the next trigger.

2. EXTERNAL RESET

The sweep may be armed remotely by means of a contact closure introduced through the two-contact socket located on the rear of the instrument. See Figure 2-15.

The Du Mont Type 4001 Sweep Rearming Kit is available as an accessory for remote rearming of the sweep. All the necessary parts and complete instructions for installation of this kit will be found in Section 4 of this manual.

d. SWEEP EXPANSION (UNCALIBRATED)

When the X VERNIER control is set fully clockwise but with its switch not actuated, sweep expansion about the center of the sweep up to a ratio of 5 to 1 continuously variable may be obtained. Under this condition, using the X POSITION control enables any portion of the expanded sweep to be displayed on the screen.

e. SWEEP EXPANSION (CALIBRATED)

1) To calibrate expanded sweep, proceed as follows:

Set front-panel controls as follows:

Control	Position
X VOLTS/CM	AUTO
Y VOLTS/CM	CAL
X VERNIER	CAL
TIME/CM	10 MS/CM
TRIGGER SOURCE	+INT
TRIG LEVEL	PRESET

2) Adjust TIME/CM VERNIER control to obtain a display of 10 cycles full scale of the calibrator waveform.

3) Adjust X VERNIER control to obtain a display of only 2 cycles full scale. The Sweep Expansion is now 5 to 1.

4) Changes in sweep time and sweep vernier settings, and changes in mode of sweep operation (Driven, Auto, Single) will not effect the calibration. Care must be exercised not to accidentally move the X VERNIER control from the previous setting. Resetting the X VERNIER control to CAL will restore the horizontal deflection amplifier for X1 expansion. This procedure may be used to adjust at any rate from 0.8 to 1 to 5 to 1.

f. OBTAINING LOWER SWEEP WRITING RATES

Obtaining lower sweep writing rates than are provided for in the instrument is accomplished by using external sweep capacitors.

The lowest sweep rate available in this instrument without using external sweep capacitors is 10 seconds full scale or 1 second/cm with the TIME/CM switch set to 200 and the TIME/CM VERNIER control set fully counterclockwise. To make connections for lower sweep rates, proceed as follows:

> CAUTION
>
> THE EXT SWP CAP TERMINALS ARE 150 TO 250 VOLTS ABOVE GROUND. USE ONLY INSULATED CAPACITORS WITH THEIR CASES NOT CONNECTED TO EITHER TERMINAL

1) Turn power off.

2) Remove cover on rear of unit to gain access to EXT SWP CAP terminals.

3) Connect external capacitor with short shielded leads.

4) Replace cover.

The sweep rate will be reduced by 2 to 1, that is, from 1 second/cm to 2 seconds/cm by addition of a 0.12 μf 200-volt capacitor. Refer to Figure 2-14 to determine other values of external capacitance and sweep rate.

The addition of the external sweep capacitance will affect the sweep rate for the 6 longest positions of the TIME/CM switch, extending each range by the factor:

$$\frac{C}{0.12} + 1 \qquad \text{(See Figure 2-14)}$$

A high-leakage-resistance capacitor of the best quality is recommended. Ordinary paper capacitors have high temperature coefficients and poor recovery characteristics. The results obtained in extending the sweep range will depend entirely on the quality of the external capacitor. Polystyrene dielectric is recommended. Electrolytic capacitors should not be used.

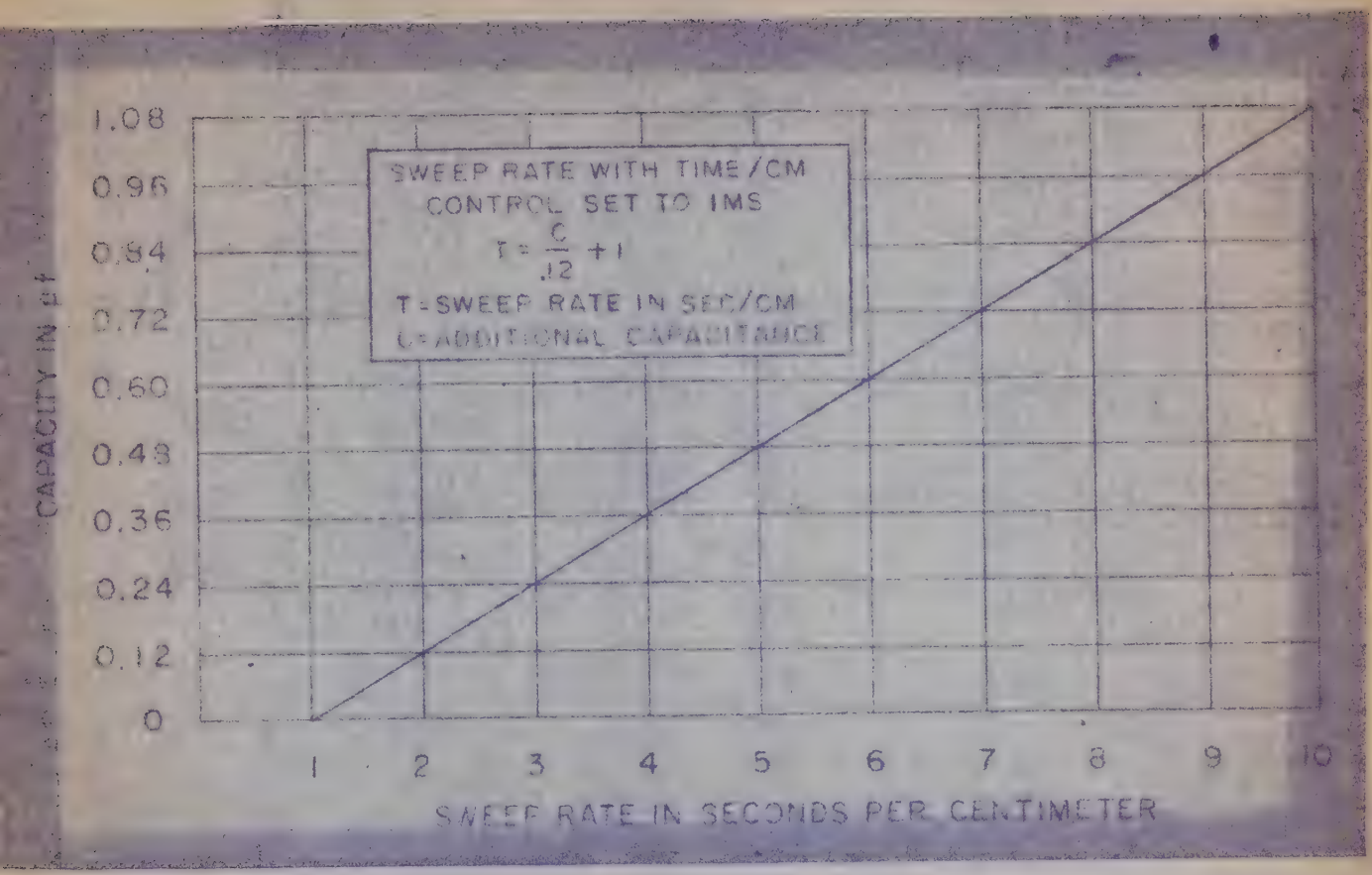


FIGURE 2-14. ADDITIONAL CAPACITANCE VERSUS SWEEP RATE

g. **REDUCTION OF EXPANDED SWEEP TO ZERO**

In order to reduce sweep amplitude to zero when the VERNIER control is set fully counterclockwise, the following modification should be made.

Short out resistor R1214, located on the X VERNIER control R1215.

When this modification has been performed, care must be exercised to avoid overloading the X Amplifier when displaying X-Y plots.

2-15. REAR-INPUT FACILITIES ON THE 440R

With one exception, the rear-input facilities on both the bench and rack models are identical. In the rack model, the front panel binding posts are duplicated in the rear of the instrument. Two slide switches are provided on the front panel of the rack-mounted version, one in the X and one in the Y circuit. When positioned to the left, the front binding posts are connected to the specific amplifier and the rear terminals are out of the circuit. When positioned to the right, the rear binding posts are connected to the specific amplifier and the front terminals are out of the circuit. Do not use the Type 4290 Probe for rear-panel applications since these connectors have capacitance of over 100 μf and will not permit tuning of the probe.

2-16. DEFLECTION PLATE CONNECTIONS

a. GENERAL

When applying signals to deflection plates, the highest frequency signal that can be observed is not limited by the response of the built-in amplifiers, but is dependent upon the source impedance of the input signal, the input capacitance to the deflection plate terminals, and/or transit time of the electrons between the deflection plates. Provided the impedance of the signal source is kept sufficiently low, transit time is the only consideration. It should be remembered however, that no amplification or attenuation is provided on direct input. See Table 1-1 for deflection sensitivities.

b. DIRECT DEFLECTION PLATE CONNECTIONS

CAUTION

BEFORE MAKING CONNECTIONS, TURN POWER OFF

Direct connection to the deflection plates is made by removing links on deflection plate terminals. See Figure 2-15, and note the following:

1) External deflection plate return resistors must be provided when using AC coupling and internal positioning.

Single-ended input, 5 megohms (maximum) either plate to ground; balanced input, 10 megohms (maximum) center-tapped to ground.

2) When using DC coupling, the average dc potential of approximately 245 volts above ground should be preserved on both pairs of deflection plates for best focus; however, the astigmatism adjustment (R3105) has sufficient range for potentials from 200 to 300 volts.

3) This average dc level should be made adjustable to provide an astigmatism control for optimum focus adjustment.

4) The vertical deflection plate connecting links are normally left disconnected in order to minimize capacitive loading on the amplifier. Refer to the Schematic, Figure 6-1 for connections.

5) A loss of positioning will occur. To retain front-panel control of positioning, follow steps outlined in next paragraph.

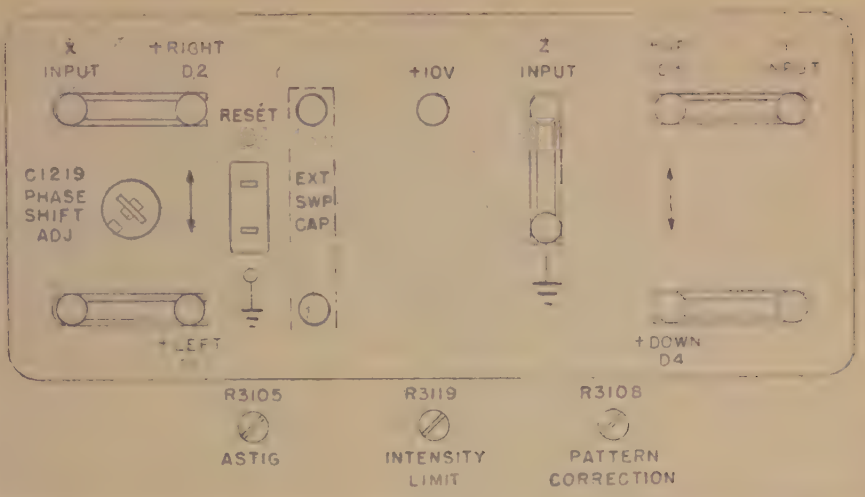
c. OBTAINING POSITIONING VOLTAGE

Removing the links when making direct connections to the deflection plates also removes the positioning voltage, making the front panel position controls inoperative. To retain front-panel control of positioning, follow the steps as outlined and refer to Figures 2-15 and 2-16.

1) Disconnect the appropriate CRT deflection-plate links from their terminals.

2) Remove links on Amplifier terminals and bridge each pair of terminals with a series resistor (4.7 megohms) in each leg. Check that the temporary Y Amplifier direct access conversion was made.

3) Connect the signal through blocking capacitors of at least 600 volts dc rating.



NAME	FUNCTION
EXT SWP CAP	Provides connection for external sweep capacitor when TIME/CM switch is set to its 6 slowest sweep rate settings. These terminals are at +150 to +250 volts.
X INPUT	Terminals D1 (left) and D2 (right) provide direct connection of signals to the horizontal deflection plates with jumpers removed. The two terminals on extreme left are the output of the horizontal amplifier and are connected by jumpers to the horizontal deflection plate terminals D1 and D2. These terminals are at a +245V dc level.
Y INPUT	Terminals D3 (UP) and D4 (DOWN) provide direct connection of signals to the vertical deflection plates with jumpers removed. The two terminals on extreme right are the output of the vertical amplifier and are connected by jumpers to the vertical deflection plate terminals D3 and D4. These terminals are at a +245V dc level. NOTE: To minimize capacitive loading of the Y Amplifier, the direct access terminals are normally disconnected. A simple wiring change will restore this feature. See schematic, Fig. 6-1.
Z INPUT	Provides connection for external signals for intensity modulation of the trace.
PHASE SHIFT CAP	Provides adjustment for zero phase differential between the X and Y Amplifiers.
+10V	Screw terminal providing a high impedance dc voltage to facilitate triggering from external contact closures. Accuracy ±20%.
ASTIG	Provides voltage adjustment for the cathode-ray tube to optimize spot shape.
INTENSITY LIMIT	Adjusted to limit brightness level with main INTENSITY control.
PATTERN CORRECTION	Adjusted to minimize pattern distortion.
RESET	Du Mont Accessory Type 4001. Supplied as kit to enable sweep to be armed remotely by means of a contact closure introduced through the two-contact socket. Note: The Du Mont Type 450 Oscilloscope Record Camera may rearm the sweep by the addition of the accessory kit.

FIGURE 2-15. FUNCTION OF REAR PANEL FACILITIES

4) To avoid any possibility of cross-coupling effects, it is suggested that when connecting a signal direct to deflection plates, the corresponding channel (X VOLTS/CM and/or Y VOLTS/CM) controls be switched to OFF.

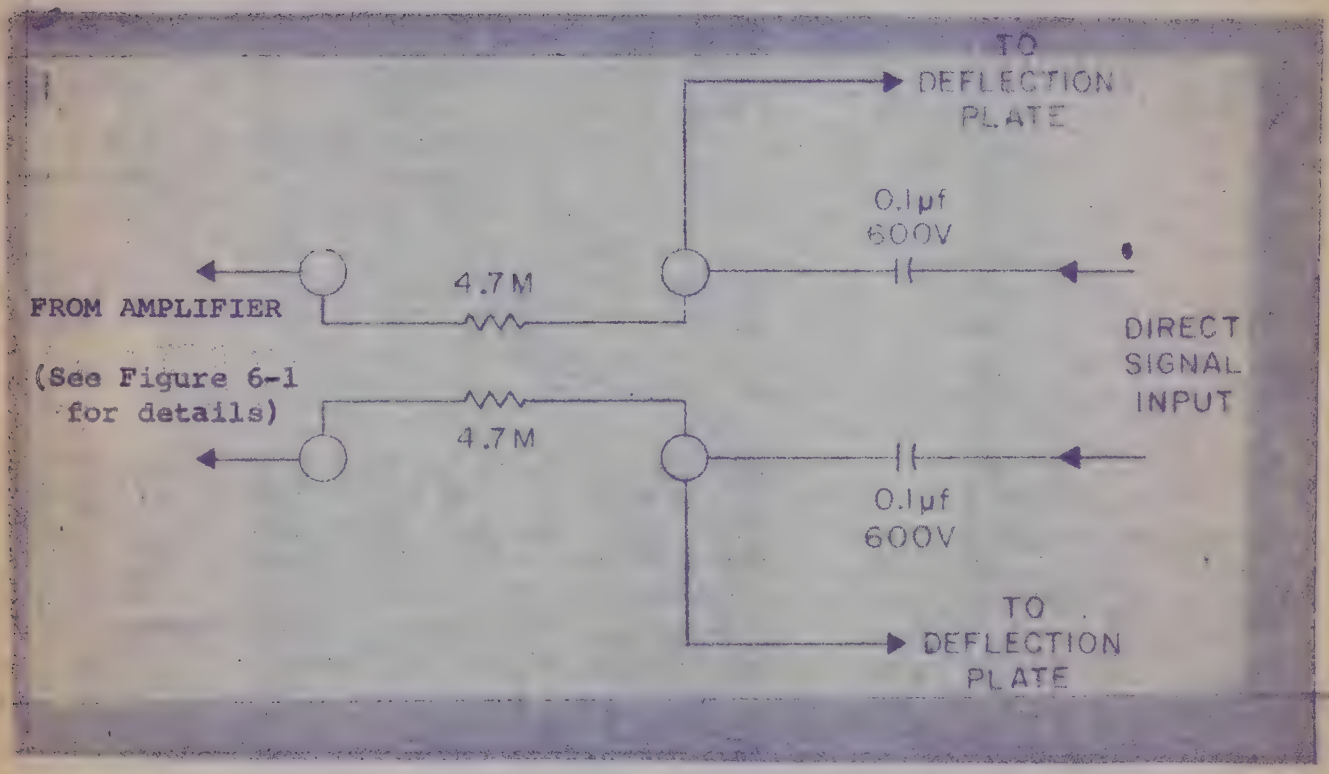


FIGURE 2-16. CIRCUIT FOR RETAINING FRONT PANEL CONTROL OF BEAM POSITION WHEN USING DIRECT SIGNAL INPUT

2-17. INTENSITY (Z AXIS) MODULATION

Positive signals applied to Z INPUT will decrease the beam intensity. To make connection for intensity modulation of the trace, turn power off, remove link and apply intensity modulation signal to the Z INPUT. Connection to the Z INPUT applies the signal between the CRT cathode and ground. A positive signal of 15 volts will cause sufficient blanking. The Z INPUT presents an impedance of 10,000 ohms and 30 pf ($\mu\mu$f) to the signal source, coupled through a 0.01 capacitor.

Always reconnect the link between the Z INPUT terminals when not using external intensity modulation.

2-18. VOLTAGE MEASUREMENTS

a. GENERAL

The Du Mont Types 440 and 440R Oscilloscopes may be used to measure the voltage of the input signal by using the calibrated Y VOLTS/CM setting and observing the height of the display on the screen in centimeters.

When making voltage measurements, the operator should try to set up the instrument for full scale vertical deflection to insure maximum accuracy. Also, it is important to remember that the width of the trace may be an appreciable part of the over-all measurement. This is particularly true when you are measuring signals of small amplitude or when stray signal pickup has broadened the trace. The operator should consistently make all measurements from one side of the trace. If the top side of the trace is used for one reading, it should be used for all succeeding readings.

b. HOW TO MEASURE PEAK-TO-PEAK VOLTAGES USING THE CRT SCALE

The procedure employed for all voltage measurements is basically the same. The Y VERNIER control must be switched to CAL (pushed in). The specific examples that follow are intended to show the general procedure. These examples may be adapted to fit any particular application.

To measure the ac component of the signal on display, set the Y INPUT Selector switch to A/AC. In this position, only the ac components of the input signal are displayed

on the screen. However, when the ac component of the input is of very low frequency (under 10 cps), set the Y INPUT Selector switch to A/DC to prevent errors. To make measurements, proceed as follows:

1) Using the calibrated scale, measure the vertical deflection in centimeters from the positive peak to the negative peak of the waveform. See Figure 2-17.

2) Multiply the vertical dimension obtained in Step 1) by the Y VOLTS/CM control setting to obtain the indicated voltage.

3) Multiply the indicated voltage obtained in Step 2) by the attenuation factor of the probe, if one is used, to obtain the actual peak-to-peak voltage.

For example, suppose that you are using a 10:1 Attenuator Probe and the Y VOLTS/CM control is set to 0.1. Assume that the vertical distance between the peaks of the waveform measures 4 centimeters. Now, the vertical dimension of 4 centimeters is multiplied by the Y VOLTS/CM setting of 0.1 to give 0.4 volt. Next, multiply this result by 10, the attenuation ratio of the probe. This gives 4 volts as the peak-to-peak voltage of the display waveform.

NOTE: Always make sure that the VERTNIER control is pushed in when making measurements.

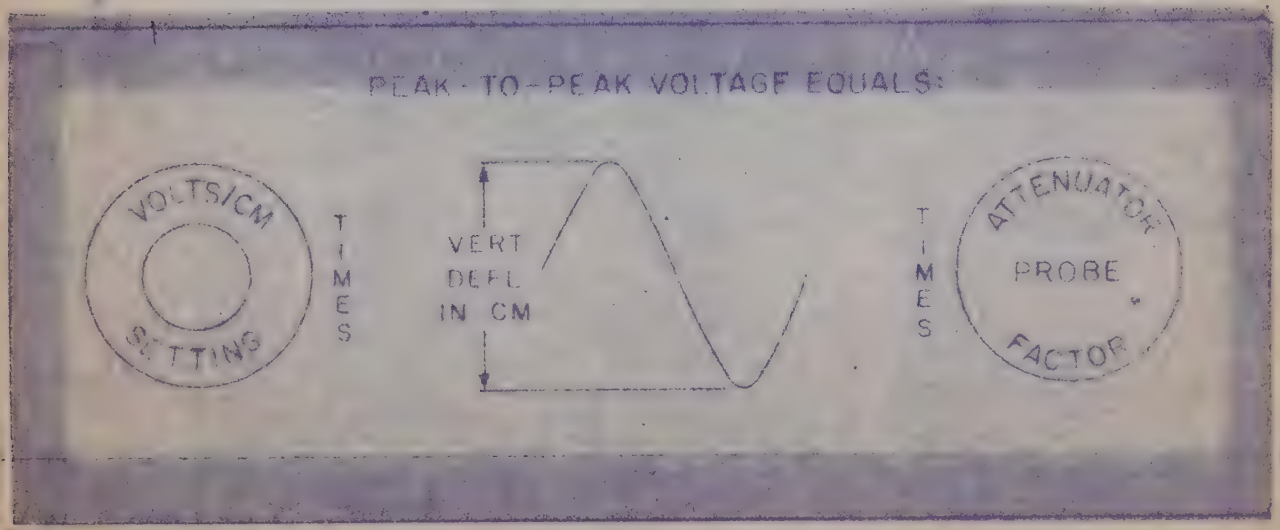


FIGURE 2-17. PEAK-TO-PEAK VOLTAGE MEASUREMENTS

c. HOW TO MEASURE INSTANTANEOUS VOLTAGES WITH RESPECT TO GROUND (OR SOME OTHER REFERENCE POTENTIAL) USING THE CRT SCALE

The technique used for measuring instantaneous voltages with respect to a reference point, is virtually the same as that described for peak-to-peak voltage measurements. The difference is that now a reference point must be established on the screen of the oscilloscope. Since voltage measurements with respect to ground are the most common, the procedure which follows, establishes ground as the reference point. The same general technique may be used for instantaneous measurements with respect to any other potential, just so long as that potential is employed to establish the reference point.

To make measurements, proceed as follows:

1) Set the Y INPUT Selector switch to A/DC.

2) Set the TRIG LEVEL control to PRESET, TRIG IN switch to AC, and X VOLTS/CM switch to AUTO.

3) To establish the reference point, touch the probe tip to the ground terminal on the oscilloscope (or to the desired source potential, if a point other than ground is used). Vertically position the trace to a convenient point on the screen. This point should be chosen so that it lies on one of the major horizontal scale divisions. The chosen horizontal scale line, which is now coincident with the trace, is the reference line from which all voltage measurements are to be made.

4) Disconnect the probe tip from ground and connect it to the signal source without distrubing the POSITION control.

5) Adjust the oscilloscope controls for a suitable and stable display.

6) Using the calibrated scale, measure the vertical deflection in centimeters from the desired point on the waveform to the pre-established reference line set up in Step 3). See Figure 2-18.

7) Multiply the vertical dimension obtained in Step 6) by the Y VOLTS/CM control setting to obtain the indicated voltage. Make sure that the Y VERNIER knob is pushed in.

8) Multiply the indicated voltage obtained in Step 7) by the attenuation factor of the probe used to obtain the actual instantaneous voltage.

For example, suppose that you are using a 10:1 Attenuator Probe and the Y VOLTS/CM control is set to 0.1. Assume that the vertical distance between the desired point on the waveform to the pre-established reference line is 4 centimeters. Now, multiply this vertical deflection of 4 centimeters by the Y VOLTS/CM setting of 0.1 to give 0.4 volt. Next, multiply this result by 10, the attenuation factor of the probe. This shows that the instantaneous voltage with respect to ground to be 4 volts. Since the voltage point is above the reference line, the indicated polarity is positive.

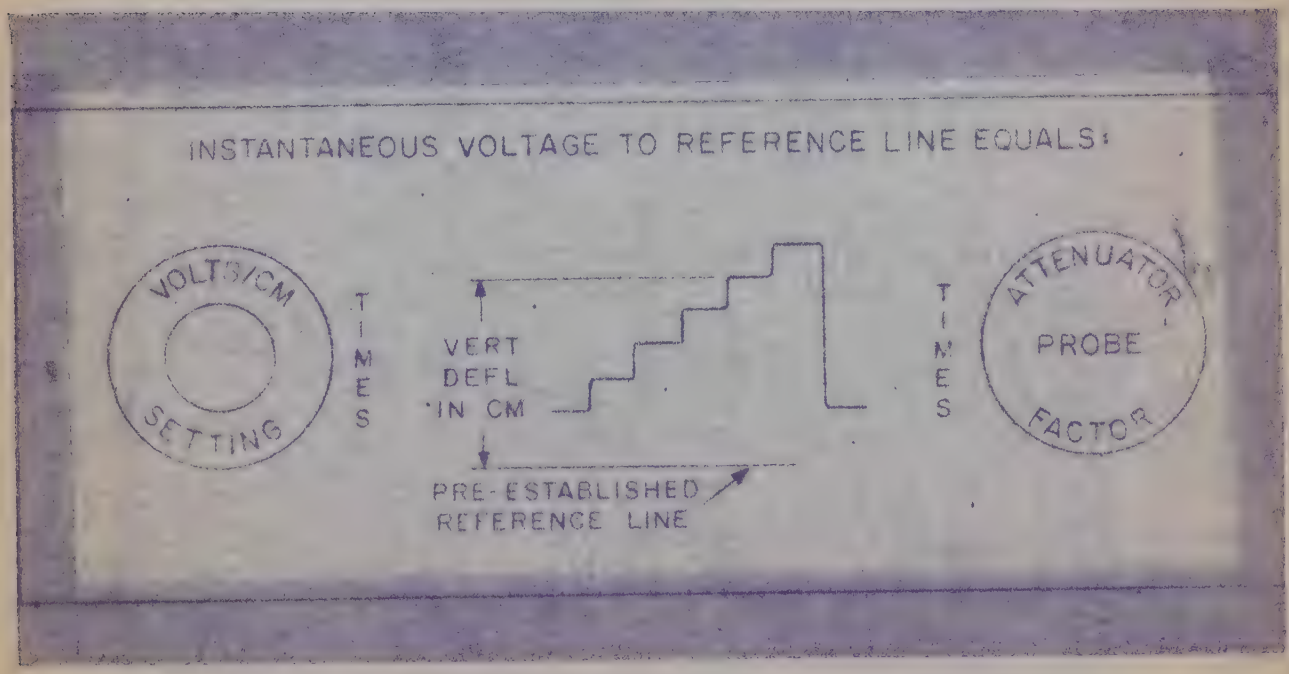


FIGURE 2-18. INSTANTANEOUS VOLTAGE MEASUREMENT WITH RESPECT TO GROUND (OR SOME OTHER REFERENCE POTENTIAL)

2-19. TIME MEASUREMENTS

a. HOW TO MAKE ELAPSED TIME MEASUREMENTS USING THE CRT SCALE

Any horizontal distance on the screen of the oscilloscope can be used to represent a precise interval of time, when the time-base circuits are set up for calibrated sweep (X VERNIER in Cal position). Use of this feature permits you to accurately measure the elapsed time between the desired point of interest on the display. To measure the time interval, proceed as follows:

1) Using the calibrated scale, measure the horizontal distance in centimeters between that portion of the display whose time interval you wish to find.

2) Multiply the horizontal dimension obtained in Step 1) by the TIME/CM control setting to obtain the time interval. See Figure 2-19.

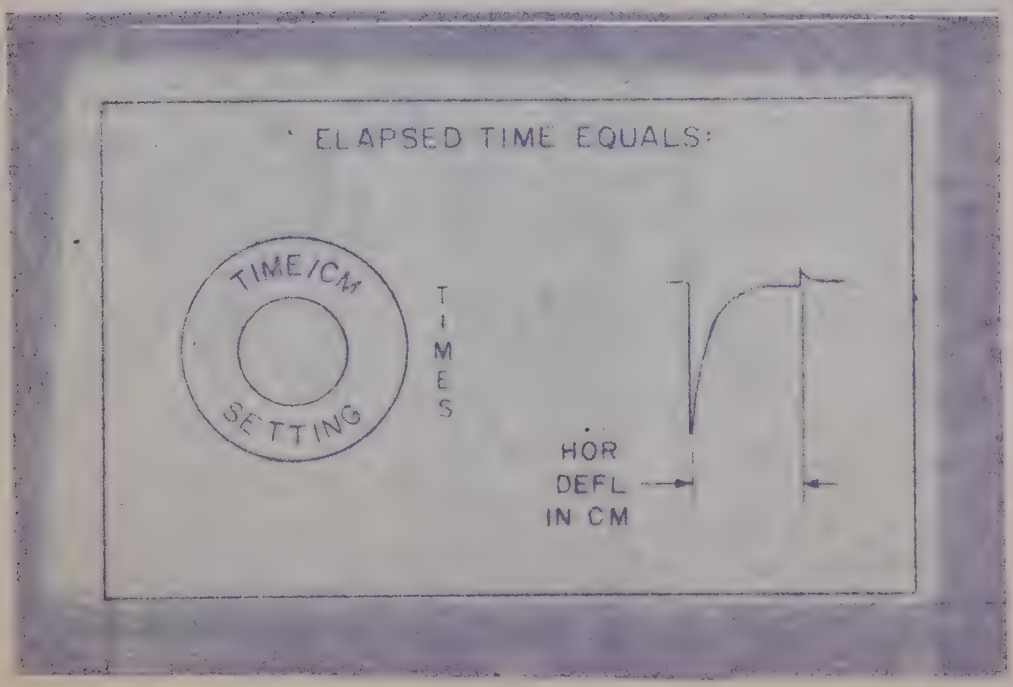


FIGURE 2-19. ELAPSED TIME MEASUREMENT

b. HOW TO FIND REPETITION RATE OR FREQUENCY USING THE CRT SCALE

The repetition rate or frequency for periodic signals can be expressed as the number of cycles or pulses per unit of time. To use the oscilloscope for measuring the repetition rate or frequency of periodic signals, proceed as follows:

1) Using the calibrated scale, measure the horizontal distance in centimeters occupied by one cycle of the display under observation.

2) Multiply the horizontal dimension obtained in Step 1) by the TIME/CM control setting.

3) Take the reciprocal of the product obtained in Step 2) (that is, divide it into one). The resulting quotient is the desired frequency or repetition rate in cycles per second. See Figure 2-20.

$$\text{Cycles/second} = \frac{1}{\text{Time(seconds)}}$$

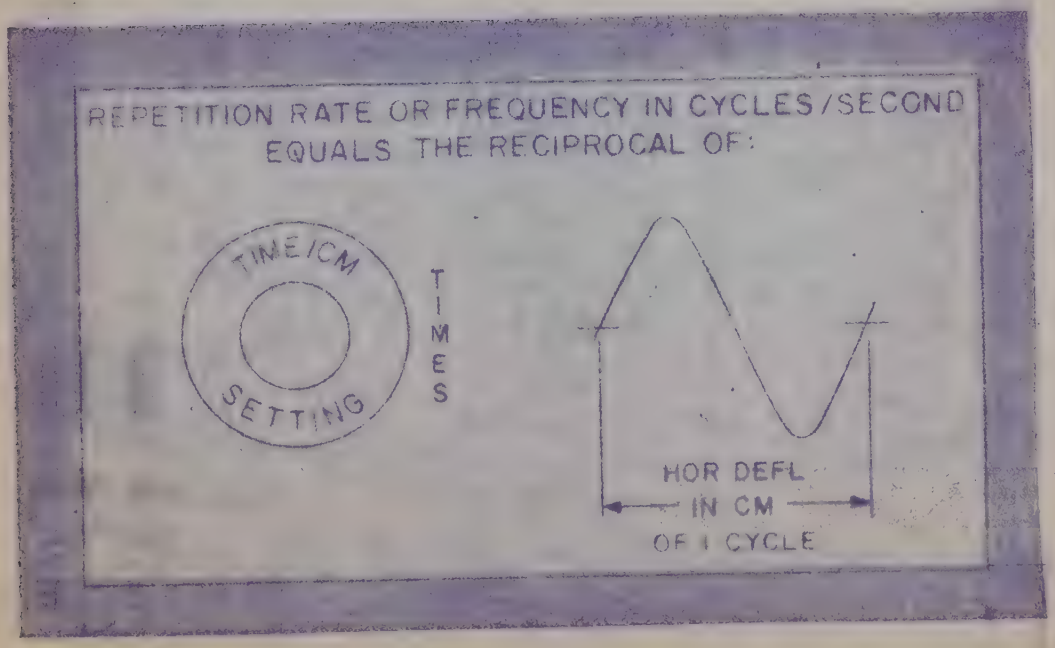


FIGURE 2-20. FINDING THE FREQUENCY

2-20. RISE-TIME MEASUREMENTS

Application of signals from an external time calibrator will facilitate pulse rise-time measurements. When making such measurements, the one factor which must be borne in mind for most accurate quantitative results is the pulse response characteristic of the vertical amplifier. This characteristic is related to the observed pulse rise time and the actual pulse rise time in the following manner:

$$t_p = \sqrt{(t_o)^2 - (t_a)^2}$$

Where: t_p = actual pulse rise time in microseconds

t_o = observed rise time of pulse displayed on oscilloscope in microseconds

t_a = amplifier rise time in microseconds (Type 440 $Y_{ta} \approx 0.07$ μsec)

Once the amplifier rise time is known (see Table 1-1), the rise time of any pulse may be calculated.

To make rise-time measurements, proceed as follows:

1) Adjust pattern for full scale (10 cm) of vertical deflection.

2) Using the X and Y POSITION controls, adjust the display vertically so that the start of the waveform rests 1 centimeter below the scale horizontal center line and the rising portion of the waveform intersects the zero point on the scale (labeled A in Figure 2-21). Observe that the top of waveform is off screen. Be careful not to accidentally change the setting of the X POSITION control.

3) With the Y POSITION control, move the waveform down until the top portion of the waveform rests 1 centimeter above the horizontal center line.

4) Note where the rising portion of the waveform intersects the X axis (labeled B in Figure 2-21).

5) Measure the distance between points A and B; multiply this reading by the TIME/CM switch setting to obtain rise time.

6) For example, if the distance between points A and B is 3 centimeters and the TIME/CM switch is set to 5 μs, the rise time would be 15 μs.

7) Rise-time measurements made in this manner eliminate errors which would result from improper deflection plate alignment and incorrect interpolation.

8) Rise time of the amplifier may be checked by applying a pulse with an input rise 5 or more times faster than the amplifier.

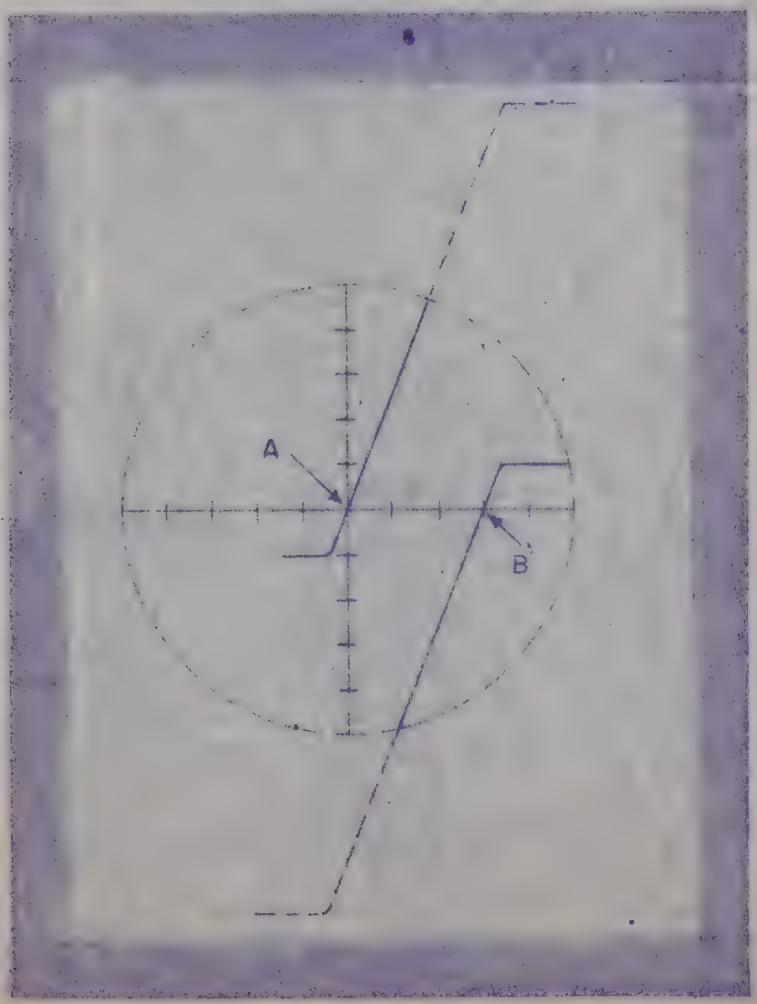


FIGURE 2-21. RISE TIME MEASUREMENT

2-21. PHASE SHIFT MEASUREMENTS

Phase measurements are usually made when the frequencies of the two input ac signals are equal. Hence Lissajous figures that results from a phase difference between two input signals of the same frequency are often referred to as phase difference patterns. When the frequencies of the two input signals are not a 1:1 ratio, the Lissajous figures are generally used for frequency measurements.

To check the relative phase shift, proceed as follows:

1) Apply a sine wave signal to both the X and Y INPUT.

2) Center the trace horizontally and adjust the Y controls for 10 centimeters of vertical deflection. The pattern obtained should be similar to Figure 2-22.

3) The angle between the two signals is that angle whose sine is the ratio of A/B.

NOTE: To obtain full scale vertical deflection of 10 centimeters, it may be necessary to temporarily reduce the horizontal amplitude of the display. To accomplish this, set the X VOLTS/CM switch one step counterclockwise from its initial setting. Adjust the display for 10 centimeters of vertical deflection. Reset X VOLTS/CM switch to its original setting, recenter the display, and read dimension A in Figure 2-22.

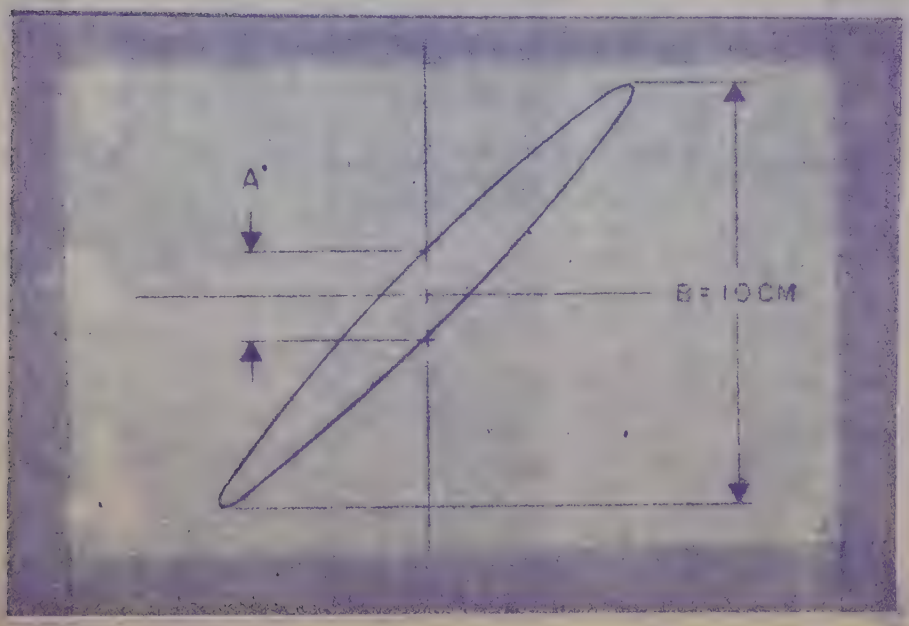


FIGURE 2-22. PHASE SHIFT MEASUREMENT

ACCESSORIES:

PROBE:
Type 4290

CONNECTOR:
G-R 9800 0629

SWEEP REARMING KIT:
Type 4001

HANDLES, RACK:
6401 2472

HANDLE, CARRYING:
6400 3730

PANEL FRONT, RACK:
3201 2531

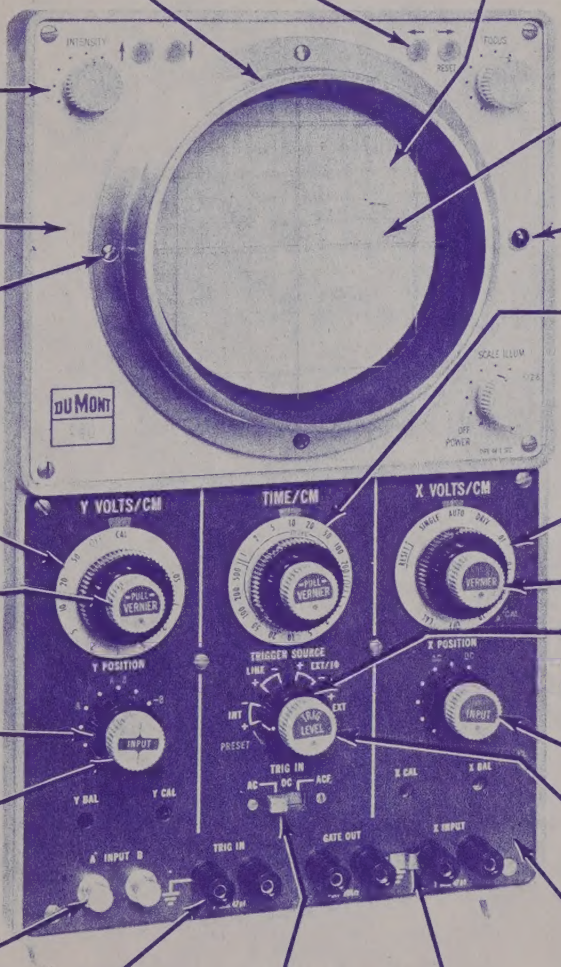


FIGURE 6-1. IDENTIFICATION OF REPLACEABLE PARTS

ACCOPRESS BINDER
BFS 2507-EMB
To hold sheet size 11 x 8½.
Also available in special sizes up to 35½" x 39½" sheet size. Specify binding side first when ordering.
Manufactured By
ACCO PRODUCTS
A Division of NATSER Corporation
Ogdensburg, New York, U. S. A.

MP MASTER
MA34324
SE Laboratories
LOC: BB2
MAN-05055